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ABSTRACT

Two topics are currently being greatly discussed in educational literature: (a) summer programs and (b) minority in mathematics and science. The Lincoln Foundation summer program provided participants with 4 weeks of instruction in math and science. The goal of the program was to enhance students' ability to succeed in high-school level mathematics and science courses. The evaluation design called for the use of a pre- and post-test and parent and teacher surveys. The data indicated that the program is achieving its objective of increasing students' content knowledge in the various subject areas. The results of the parent survey indicated the high levels of satisfaction with the program. Results from the teacher survey showed overall agreement with the professional development model and instructional support. Highlighted curricular methods include: cooperative learning; activity-based lessons; and small group techniques. Implications for practice and recommendations for improvement are included. (Author/YDS)

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ED 463 149

Running head: Minorities in Math and Science

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1

Educational Opportunities for Minority Students: Lessons Learned from a Summer High School Math and Science Program

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Abstract

This process and product evaluation addressed two topics that are currently greatly discussed in the educational literature: (a) summer programs and (b) minority in mathematics and science. The Lincoln Foundation summer program provided participants with four weeks of instruction in math and science. The goal of the program was to enhance student's ability to succeed in high school mathematics and science courses. The evaluation design called for the use of a pre- and post-test and parent and teacher surveys. As the data in the following report indicate, the program is achieving its objective of increasing students' content knowledge in the various subject areas. The results of the parent survey indicated the high levels of satisfaction with the program. The teacher survey result showed an overall high support for the professional development model and the instructional support. The highlighted curricular methods include cooperative learning, activity-based lessons, and small group techniques. Implications for practice and recommendations for improvement are included.

Keywords: Minority Students, High School, Mathematics, Science, Academic Achievement, Summer School, Professional Development

INTRODUCTION

Description of the Lincoln Foundation Math and Science Program

The Lincoln Foundation Summer Math and Science Program is offered to all Jefferson County high school students who have completed the eighth, ninth, tenth, or eleventh grade. This program was originally designed to enhance gifted minority students abilities to succeed in their high school mathematics and science courses. This year the program was open to all students entering high school, regardless of race, ethnicity or academic standing.

Located on the campus of the University of Louisville, the program operated on a budget of $89,000, funded primarily by Jefferson County Public Schools (JCPS) and served 387 students (approximately $230.00 per student). The Lincoln Foundation Summer Math and Science Program extended over four weeks and included two 90-minute classes Monday through Friday. Students having difficulty in their classes were offered one hour tutoring sessions following regular classes. The Lincoln Foundation recruited and hired 10 subject area teachers to provide instruction to the students. The Jefferson County Public School system provided five resource teachers who facilitated the professional development and curriculum design. The following courses were offered: Algebra 1, Algebra 2, Geometry, PreCalculus, Biology, Chemistry, Anatomy/Physiology and Physics. The objective of the program was to enhance participant's ability to succeed in their high school mathematics and science courses.

Program Components

The Lincoln Foundation program had two basic components: mathematics and science instruction for students and professional development for the participating teachers. A description of each follows.

Mathematics and Science Instruction

The curriculum was designed to match state mandated core content and to foster performance tasks and real life applications of science and mathematics. The ultimate objective was to provide instruction that would prepare students for high school mathematics and science courses at all levels. For example, the Algebra component provided students with experience using manipulatives. Students were required to use graphing calculators and graph and analyze original data. The Science courses emphasized using inquiry-centered activities for instruction. In Biology, for example, science lessons provided students with the opportunity for observation, data collection, reflection and analysis. Other Biology activities encouraged critical analysis of written materials.

Professional Development

Teachers received a total of 38 hours of professional development during the course of the program. Five resource teachers prepared and implemented the professional development for the ten core subject teachers. For three days prior to the program, teachers met to review the curriculum that the resource teachers had compiled. In addition, each afternoon during the four-week program, resource teachers met with content teachers for one hour in order to clarify lessons and modify the instruction for the following day.

This format for professional development was modeled after the 'Rising Star' professional development model. This model for professional development is designed to have a long-lasting impact on the teachers. The resource teachers demonstrated and modeled hands-on methods of classroom instruction. The teachers were then expected to implement these teaching methods with their students in the summer program. It is assumed that the teachers will continue to provide hands-on instruction during the regular school year to their students.

REVIEW OF THE LITERATURE

To be meaningful, this evaluation must be viewed in the general context of research related to (a) minority representation in science and mathematics and (b) educational summer programs. Minority students are underrepresented in science and mathematics course at every level from elementary to graduate school (Oakes, 1990). Lack of preparation in science and mathematics among under-represented minority groups in middle and high school ultimately limits college and career choices latter in life (Clark, 1999). Minority students make up the most rapidly growing portion of our school-aged population, but are the population who are most left out of science and mathematics programs and course offerings. Research has shown that lack of pre-college preparation is the single most important cause of under representation of minorities in science and engineering careers (Hayden as cited in Oakes,1990). There is a need for documentation of successful interventions that enhance the science and mathematics performance of minority youth.

The dilemma of how to increase the flow of minority students into the scientific "pipeline" has been well documented (Culatta & Gibbons, 1992, Stevens, 1993). To date, millions of dollars have been spent on government programs targeted at improving minority representation in science and mathematics, but the impact of these programs is questionable. In a study by Culatta and Gibbons (1992), seven explanations are provided for the weakness of existing programs (a) programs were run with little oversight or assessment; funding did not depend on results, (b) there was little real commitment from the top or from most faculty, (c) programs had vague or unrealistic goals, (d) funding was inconsistent, (e) programs ignored subtle psychological issues such as low expectations on the part of teachers, (f) colleges recruited unprepared minority students and then provided little support, (g) programs targeted college- aged students or higher, instead of going to the root of the problem in elementary, middle and high schools. One widely accepted approach to encourage minority participation in science and mathematics is through summer programs.

Public and private agencies have invested billions of dollars in the past twenty years on a wide range of summer programs. Until recently, the majority of school summer programs offered to students were designed to provide a pressure-free, noncompetitive environment in which young people could explore a particular area of interest in depth (Ware, 2000). Currently, there has been a movement towards mandatory summer program designed for low performing students (Pipho, 1999). A recent survey of the largest 100 U.S. school districts found that 59 had established summer programs to help students who might otherwise have been held back; 55 said they had summer classes because they needed to meet new state standards; and 17 said they wanted to provide remediation. Only 16 said they created the program because they wanted to offer enriched courses. (Borman, cited in Mathews, 2000). Critics of summer school programs point out that most programs are focused on remedial lessons instead of enrichment (Mathews, 2000). Hahn (1992) identified four essentials for quality programs (a) well managed service delivery system, (b) effective targeting and recruiting, (c) a well-articulated and consistent identity and (e) sound leadership and effective staff. The greatest challenge to summer remediation programs is the lack of research showing that such programs work.

EVALUATION DESIGN

Evaluation Objectives

This evaluation was designed to answer the following questions:

- What are the characteristics of the students participating in the program?
- What are the teacher's affective responses to different components of the program?
- What are the parent's affective responses to different components of the program?
- What is the impact of the summer program on student's content knowledge in science and mathematics?

Evaluation Model

Stuffelbeam's (1971) CIPP model provided the framework under which this evaluation was designed. CIPP is an acronym for the four types of evaluation included in this model: Context evaluation, Input evaluation, Process evaluation, and Product evaluation. The main features of this evaluation include the results from the process evaluation identifying how the program was implemented and the short-term product evaluation assessing the short-term outcomes of the summer program.

EVALUATION METHODS

Participants

Three hundred and eighty seven students participated in the program. The racial makeup of the participants was 84 % African-American, 12% White, 3 % Asian and 2% other. The greatest majority of the students (47%) were scheduled to enter 9^{th} grade in the fall of the following year. Twenty five percent were scheduled to enter 10^{th} grade, 18% to enter 11^{th} grade and 10% to enter 12^{th} grade. One percent of the students were from ECE classrooms. Additional demographic information is provided in Table 1.

Instrumentation

Content Knowledge Pre and Posttest

Pre and posttests were developed to assess the impact of the program on student's content knowledge. The teachers constructed ten content area tests. The teachers established face validity of the instrument. A pretest was given on the second day of the program. A posttest was given on the last day of the program.

Parent student and teacher surveys

Three surveys were developed to assess the affective responses of the students, teachers and parents. Lincoln Foundation program evaluation forms were distributed to parents on the Wednesday of the final week of the program. All of the data from the returned surveys were entered into SPSS and descriptive statistics were calculated. In addition the surveys provided open-response questions, which allowed students, parents and teachers to elaborate on their impressions of the program.

EVALUATION FINDINGS

Process Evaluation

What are the characteristics of the students participating in the program? As described in Table 1., this program served largely African American students entering ninth or tenth grade. The majority of the students were female (n=205). Approximately one-third of the students served participate in the free and reduced lunch program.

Attendance rates were calculated for each week of the summer program. There was little fluctuation in absenteeism during the course of the program. For the first week of the camp, 12 % of the students were absent. During the second week of the camp 14% of the students were absent and 13% were absent for the third week of the camp. The highest absentee rate occurred during the last week of the camp, with 15% of the students absent. The average absentee rate for the entire summer program was 13.4%.

What are the parents of the participant's impressions of the program? There was a low return rate for the return of parent evaluation forms, with only twenty-one percent (n=85) individuals responding. The results are shown in Table 2. More than 87% of the parents who responded to the survey felt that the quality of education provided by the Lincoln Foundation was excellent. Several parents provided qualitative responses to the survey. The two most common responses offered overall praise for the program and criticism of disruptive student behavior. The following quotes illustrate this point; "My child had a difficult time in math because the students were too noisy... I feel this program is good even though she had a difficult time. I would recommend this program" and "My child stated the disruptive behavior of several students kept him from learning at times."

TABLE 1.

Student Profile of the Participants in the High School Math/Science Program

Variable		Frequency	Percent
Race			
	Asian	9	2.8%
	Black	273	83.5%
	Other	7	2.1%
	White	38	11.6%
Gender			
	Female	205	62.7%
	Male	122	37.3%
Lunch Status			
	Free	67	20.5%
	Reduced	40	12.2%
	Pay	220	67.3%
Grade			
	8^{th}	152	46.5%
	9^{th}	80	24.5%
	10^{th}	59	18%
	11^{th}	33	10.1%
	ECE	3	.9%
Type of School			
	Private	23	7.57%
	Public	304	92.43%

Note: The total enrollment was 395 students. The total number of students with unique identification number were 327, representing 83% of the total enrollment.

TABLE 2

Parent Survey Responses

Question

1. I believe my child was encouraged to do his/her best work.
   89% Agree
   2% Disagree
   9% Neither Agree nor Disagree

2. The camp provided a positive learning environment for my child.
   88% Agree
   1% Disagree
   11% Neither Agree nor Disagree

3. The work my child did in this camp is important.
   92% Agree
   1% Disagree
   7% Neither Agree nor Disagree

4. I believe my child will be prepared for high school math and science.
   83% Agree
   4% Disagree
   13% Neither Agree nor Disagree

5. The instructional methods used were effective for my child.
   82% Agree
   4% Disagree
   14% Neither Agree nor Disagree

6. My child's interest in science has increased.
   82% Agree
   11% Disagree
   7% Neither Agree nor Disagree

7. My child's interest in mathematics has increased.
   50% Agree
   9% Disagree
   21% Neither Agree nor Disagree

8. The quality of education provided by this program was excellent.
   87% Agree
   0 % Disagree
   13% Neither Agree nor Disagree

Note: Five-point Likert-type scales were used. Responses indicating 5-4 =agree, 1-2 = disagree and 3 =neither

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What are the teacher's affective responses to the program? Responses to the teacher evaluation indicate overall high levels of satisfaction with the program. The following results are separated into professional development, instruction strategies used and overall assessment of specific components of the program. Teachers indicated that they were very satisfied with the professional development offered before and during the program. Table 3 details the results from the Professional Development portion of the survey.

TABLE 3

Survey Results of the Teachers Assessment of Professional Development in the High School Math/Science Program (N = 10)

Item	M	SD
1. Content was organized to provide opportunities to learn new teaching strategies	4.78	.63
2. Materials were adequately covered for understanding	4.89	.31
3. There was opportunity to try instructional strategies	4.89	.31
4. I felt adequately prepared to deliver instruction to the students	4.67	.47

Note: Five-point Likert-type scales were used (1 = Disagree, 5 = Agree). The response rate was 67%. The reliability coefficient was .61.

Teacher responses indicated a very high overall rating for the professional development. The highest ratings were given to statements related to the adequacy of materials covered during the professional development and opportunities to try out instructional strategies.

Table 4 details the instructional strategies used during the program. The instructional strategies most often used included activity-based lessons, cooperative learning groups and small group work. The least often used instructional strategy was individual student projects.

TABLE 4

Survey Results of the Teachers Assessment of Personal Instruction Strategies in the High School Math/Science Program (N = 10)

Item	M	SD
1. Activity-based approach to presenting lessons	4.50	.97
2. Cooperative learning groups	4.50	.85
3. Use of manipulatives	4.20	1.32
4. Small group work	4.70	.67
5. Board work	3.80	1.14
6. Individual student projects	2.40	1.26

Note: Five-point Likert-type scales were used (1 = Did not implement, 5 = Regularly). The response rate was 67%. The reliability coefficient was .80.

The means for the overall assessment of the program were generally high. The average rating for instructional support, professional development and administrative support were very positive. The scores were less positive for the item addressing student selection. The teachers gave student selection an average rating of 3.9. More detailed information is provided in Table 5

TABLE 5

Survey Results of the Teachers Overall Program Assessment in the High School Math/Science Program (N = 10)

Item	M	SD
1. Student selection	3.90	.74
2. Curriculum	4.70	.67
3. Class size	4.50	.71
4. Length of the program (number of days)	4.60	.52
5. Teaching supplies	4.70	.67
6. Administrative support	4.67	.47
7. Professional development	4.78	.42
8. Instructional support	4.89	.31

Note: Five-point Likert-type scales were used (1 = Poor, 5 = Excellent). The response rate was 67%. The reliability coefficient was .76.

Product Evaluation

What was the impact of the summer program on participating student's content knowledge in science and mathematics? Statistical analysis of the pre and posttest measures indicated students gained knowledge in all eight of the subject areas tested in this evaluation. The greatest gain in student knowledge occurred in Pre Calculus. The eleven students enrolled in Pre Calculus increased their score by 52% after participating in the program. The majority of the students in this years summer program enrolled in Biology (n=145). The average increase in Biology test score was 42%. Additional

information from all of the subject areas is included in Table 6. These results indicate the Lincoln Foundation had a positive effect on the participant's knowledge of science and mathematics subject areas.

TABLE 6

Comparison Between Pretest and Posttest Scores For Mathematics and Science Subject Areas

Subject	N	Mean Pretest	Mean Posttest	Percent Gain	t value
Algebra 1	83	24.34	55.87	31.53	-19.71
Algebra 2	56	34.39	53.82	19.43	-5.85
Geometry	28	30.42	45.46	15.04	-4.14
PreCalculus	11	15.00	66.67	51.67	-2.68
Biology	145	19.72	61.31	41.59	-26.73
Chemistry	47	52.51	64.85	12.34	-7.83
Physics	35	47.46	74.29	26.83	-11.16
Anatomy	12	32.67	81.50	48.83	-.823

Note. All subject areas were found to be statistically significant at $p < .05$ by the paired sample t-test.

CONCLUSION AND DISCUSSION

Strengths

An outcome of the program includes gains in content knowledge across all subject areas. There were positive difference scores from the pre and posttests for all content areas, indicating that Lincoln Foundation Math and Science Program was successful in increasing participants content knowledge. The greatest gains occurred in PreCalculus (52%), Anatomy (49%), and Biology (42%).

The curricular methods included cooperative learning, activity-based lessons and small group work. Teachers were observed using manipulatives and hands on activities as regular instructional strategies. Students were provided with opportunities to engage in problem solving activities. This is a hopeful finding in light of research that suggests that summer programs often fail because of reliance on traditional teaching strategies and teacher centered instruction (Pipho, 1999).

The rate of attendance (87%) was very high for a summer optional program. This may be due to the parent involvement in encouraging students to attend. Parents and students were asked to sign a form acknowledging they understood the importance of attendance (Appendix A). Parents were also sent attendance records of their children throughout the program. Perfect attendance awards were given out at the conclusion of the program.

Weaknesses

The main weakness of the Lincoln Foundation program was the lack of measurable objectives for the program. The stated objective of the program is to enhance the performance of participating students in the science and mathematics courses they will take in the fall. There is a need for an operational definition of enhanced performance. It is of great importance that the broad statements of purpose of an organization be defined

in concrete measurable objectives (Steiner, 1979). In addition, the current stated target audience is students entering grades 9 through 12. There is no indication of the student ability level that this program is designed to serve. According to Hahn (1992), an effective program includes effective targeting and recruiting of students. While this program was successful in recruiting students, there appear to be no clearly defined target group.

RECOMMENDATIONS

Recommendations for Improving the Summer 2001 Program

- Create measurable objectives for the professional development and student program.
- Clarify the target population and modify the selection procedure accordingly.
- In order to expedite the evaluation, utilize the scan tron equipment available through the Testing office to record pre and posttest data as well as student survey results.
- Provide teachers with more explicit disciplinary procedures. Include recommendations set forth by Lincoln Foundation staff in professional development of teachers.

FURTHER RESEARCH

This research can be extended in several ways. First, there is much to learn about the long-term impacts of this program on student's achievement in high school mathematics and science courses. An additional study is needed to evaluate the long-term impact of the program on the participant's achievement in mathematics and science as measured by GPA, scores on the CATS test and enrollment in science and mathematics classes.

A second direction for future research is to assess the implementation fidelity of the "Rising Star" professional development model. One of the objectives of the "Rising Star" approach to professional development is that the teachers transfer the knowledge and experiences gained during the summer to their own classroom. An additional study could examine the teaching practices of Lincoln Foundation teachers in their home schools to assess implementation of strategies and materials learned during the professional development. A second area of research related to professional development would examine the cost efficiency of this model and impact on student achievement.

A third topic for future research is to examine the effects of the exposure to a university campus on the Lincoln Foundation participants. Evidence from the literature indicates that summer programs that are offered on college campuses allow students the opportunity to test their assumptions about campus life. In addition, College and Universities sometimes see summer intervention programs as recruitment devices. An additional study could assess the relationship between participation in the Lincoln Foundation program and enrollment at the University of Louisville.

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Appendix A

Disciplinary procedures as Recommended by Program Staff

Absenteeism

3 absences (for any reason) result in automatic dismissal from the program

Tardiness

3 tardies (15 minutes or less) - Call home

6 tardies (15 minutes or less) Dismissal

1 tardy (greater than 15 minutes) - Call home

2tardies (greater than 15 minutes) - Immediate dismissal

Cutting

1st cut: Call home

2nd cut: Immediate dismissal

Disrespectful behavior towards staff: Immediate dismissal